

NARROWING OF THE INTERVERTEBRAL FORAMINA AS A CAUSE OF PSEUDORHEUMATIC PAIN

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DURING the last two years, 72 patients have been referred to this department for roentgenologic examination because of pain in the shoulder, the tentative diagnosis being arthritis or rheumatism. Arthritis of the shoulder was found in one case, a cervical rib in three, and narrowing of cervical intervertebral foramina in 66; in two cases, the roentgenologic findings were negative.

This observation shows, first: That compression of nerve roots as a consequence of some spinal lesion is a common cause of pain and discomfort; and, second: That the clinical findings in these conditions are often so misleading that the neurogenous nature of the symptoms is hardly recognizable.²⁹ It seems justifiable, therefore, to present some new observations concerning the differentiation and treatment of those chronic spinal diseases which, by involvement of the intervertebral foramina, give rise to segmental neuritis.

Roentgenologic Findings.—Compression of nerve roots may occur within either the spinal canal or the intervertebral foramina. Among the pathologic processes here discussed, two are known to cause compression within the canal: (1) After traumatic rupture or degenerative softening of the annulus fibrosus, the posterior part of the intervertebral disk may be displaced backward and thus bulge into the spinal canal (Williams and Yglesias,³² Alajounine and Petit-Dutaillis,¹ Mixter and Ayer,²¹ Glorieux' "Hernie nucléaire postérieure intrarachidienne"¹³); or a piece of cartilage detached from the injured disk (Dandy¹⁰), or a calcified Schmorl's nodule (Werthman and Rintelen³⁰) may likewise cause pressure upon the cord. (2) Inflammatory swelling of periarticular tissues (Nathan²³) followed by exostotic formations bulging into the spinal canal (Bailey and Casamajor,⁴ Parker and Adson²⁶) may produce signs of compression. Owing to the localization and the size of the area thus affected, the clinical findings, in these cases, suggest a lesion of the cord rather than of individual nerve roots. Neither prolapse of the disk nor the inflammatory processes above mentioned are revealed by direct roentgenologic evidence. Indirectly, prolapse of the disk may be assumed in the presence of a rounded defect within a myelographic filling when associated with a reduced intervertebral space at the same level (Mixter and Ayer, Glorieux). The inflammatory lesions alluded to do not produce typical roentgenologic findings.

Characteristic roentgenologic findings, however, are demonstrable in the

Submitted for publication December 10, 1936.

case of pressure upon nerve roots resulting from those diseases which affect the intervertebral foramina. The technical details of the method are given in a separate paper.²⁵ Calvé and Galland,⁷ Dansforth and Wilson,¹¹ Williams,³¹ Williams and Yglesias,³² Ayer,³ Hadley,¹⁵ Oppenheimer and Turner,²⁴ and others, have shown that acute or gradual thinning of the disk will affect both the height of the intervertebral foramen and the position of the articular processes. As the space between the vertebrae diminishes in proportion to the degree of thinning of the disk (Fig. 1), the decrease in height of the foramen is obviously due to the narrowing of the interspace, while the resulting forward displacement of the superior articular process of the subjacent vertebra produces a decrease in the lateral diameter. The considerable narrowing of the foramen thus caused (Fig. 2B) is quite sufficient to account

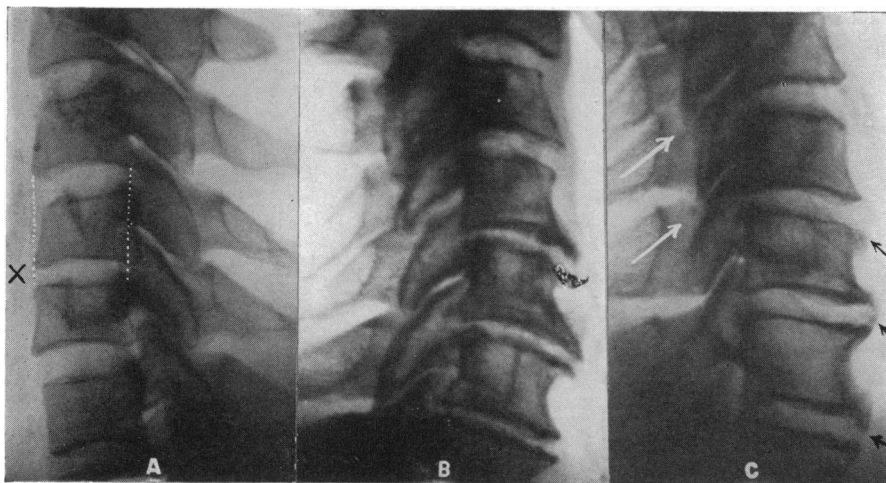


FIG. 1.—Cervical spine, lateral views. (A) Early discogenetic disease: Thinning of only one disk, consecutive displacement of the superjacent vertebra. Note the absence of any exostotic deformities. (B) Advanced discogenetic disease: Thinning of all the disks, very marked exostotic deformities limited to the vertebral bodies; the apophyseal joint spaces are wide; the articular processes free of any similar exostoses. (C) Spondylarthritis: Apophyseal joint spaces greatly narrowed, blurred (white arrows); longitudinal ligaments calcified (black arrows); disks not involved.

for marked compression of nerve roots; hence it is unnecessary to assume, under these conditions, some additional inflammatory reaction of soft tissues—which, by the way, has never been observed at operation or autopsy.

Some secondary changes, however, may complicate the picture. The displacement of the articular processes, for instance, sometimes amounts to actual contact of the bones, to impingement of the tip of the subjacent process against the superjacent pedicle (Hadley¹⁵), and even to penetration of a displaced articular process into the adjoining vertebra (Fig. 3). This may lead to intense bony reactions, shown by marked eburnation and exostotic excrescences. Small exostoses on the posterior margins of the vertebral bodies are often seen in oblique views (Fig. 2B) and may increase the compression already present. Almost invariably associated with larger exostoses at the anterior and lateral borders of the vertebral bodies involved (Fig. 1B),

these changes are not due to primary arthritis, but to reactions consequent upon the mechanical irritation resulting from loss of the disk, as demonstrated, in the case of the vertebral bodies, by the experiments of Keyes and

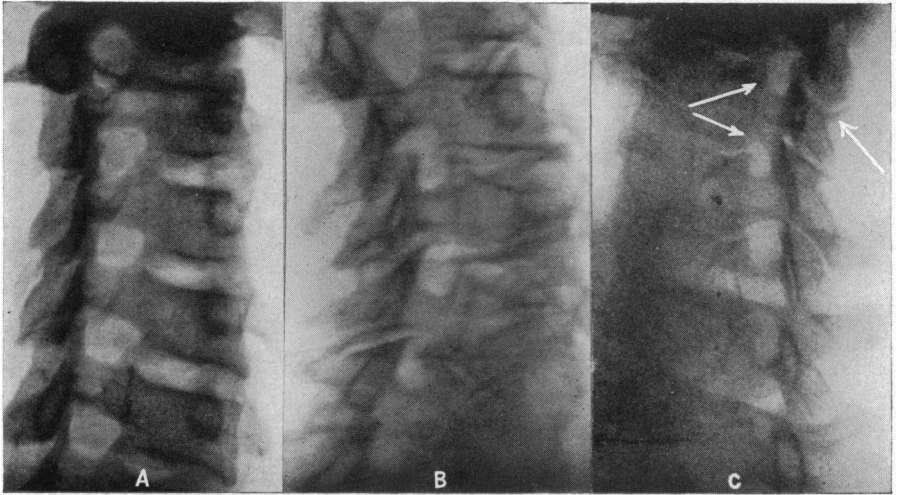


FIG. 2.—Cervical spine, oblique views. (A) Normal foramina. (B) Discogenetic disease: Anterior subluxation of inferior articular processes causing narrowing of foramina; exostoses at the posterior margins of the bodies; apophyseal joints free. (C) Spondylarthritis: Constriction by arthritic deformities (one arrow) and calcification of ligamenta flava (two arrows).

Compere.¹⁹ As it is primarily the morbid condition of the disk which initiates all the changes now under discussion, the term “discogenetic disease,” suggested in a previous report,²⁴ is adopted in this article. Among the various

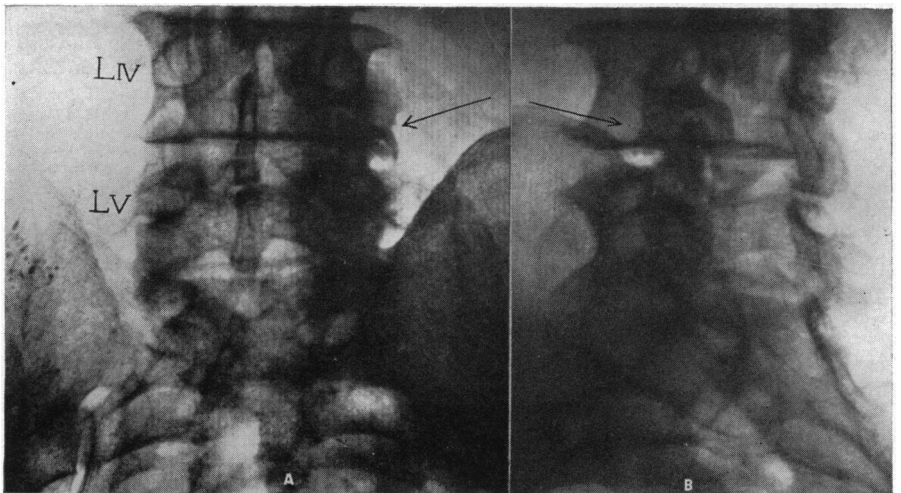


FIG. 3.—Unilateral (left) penetration of inferior articular process into superjacent vertebra; disks greatly thinned. Extensive bony reaction.

processes that induce hypertrophic deformities of the spine, the importance of this common disease has not yet been sufficiently appreciated.

The roentgenologic findings are quite definite in advanced cases, where the

thinning of the disk results in marked narrowing of the intervertebral space. Williams and Yglesias³² have pointed out that the disk may be thinned only in its posterior portion, whereby, in the lateral view, only the posterior part of the interspace appears narrowed. Another condition, which we have not found mentioned in the literature, consists in unilateral thinning, either left or right, of the disk, resulting in a strictly unilateral neuritis (Fig. 4). Clinical observations make it probable that this unilateral thinning is common; for, generally speaking and for a long time, the symptoms are limited to one side; but, with the progress of the disease, the whole of the disk collapses, thereby causing a shifting of the pain to the other side, and resulting finally in bilateral paresis of certain groups of muscles.

Narrowing of an intervertebral foramen may be produced also by a particular lesion hitherto undescribed. In this condition, there is no sign of

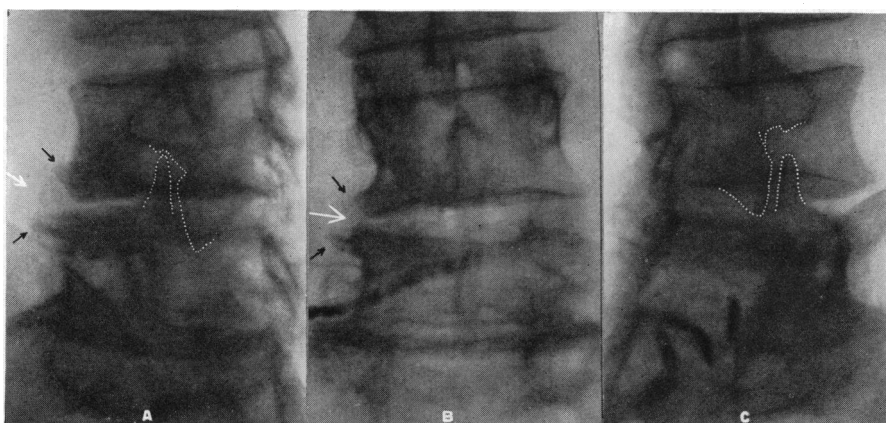


FIG. 4.—Unilateral thinning (right) of fourth lumbar disk; obliteration of lumbosacral space. Note that exostoses are limited to the side narrowed (arrows). Bony contact between articular processes in (A), as compared with normal position on the left side (C).

involvement of the disks. In four cases of severe radiculitis, we have observed, in one inferior articular process, circumscribed defects produced by a kind of bore-hole drilled, as it were, by the superjacent articular process into the facet (Fig. 6). This results in narrowing of the posterior part of the foramen. The articular process is decreased in height and its bony structure appears less regular than that of the neighboring bones. In three cases, it was the sixth cervical vertebra which showed these changes; in one, the seventh cervical. Even in normal spines, the inferior articular processes of these vertebrae are often found thinner than those of the adjacent vertebrae. The angulation at the junction of cervical and dorsal spine also causes these articular processes to approach each other closely, especially during posterior stretching of the neck. It is conceivable, therefore, that the increased mechanical stress at this level is equivalent to the kind of trauma known to facilitate, in other bones, the localization of an infection (*e.g.*, tuberculosis or osteomyelitis). In two cases, pulmonary tuberculosis was found on both clinical and roentgenologic examination.

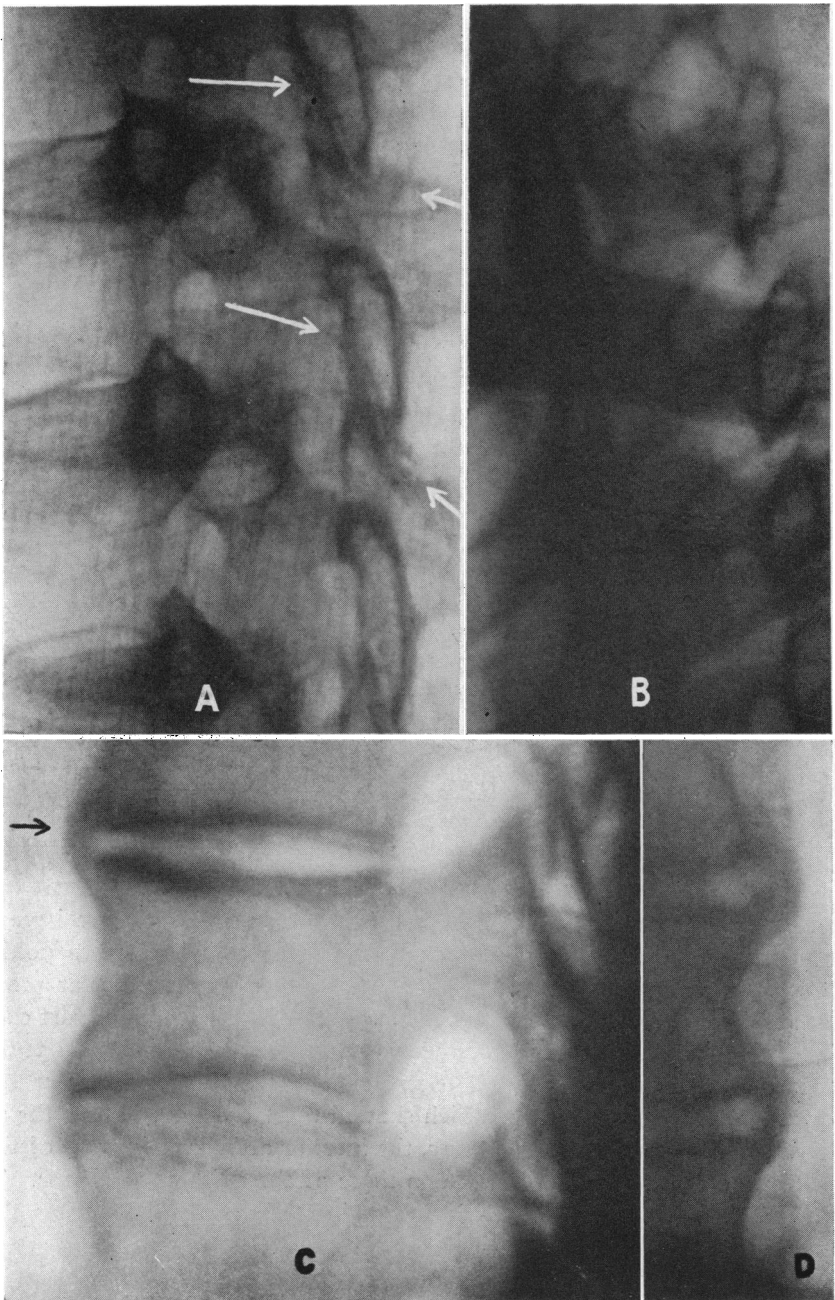


FIG. 5.—Ankylopoietic spondylarthritis. (A) Ankylosis and arthritic deformities of the dorsal apophyseal joints. (B) Normal dorsal joints. Compare the width of the joint spaces. (C) Calcification of anterior, and (D) of lateral longitudinal ligaments.

The production of neuritic symptoms by destructive lesions (Pott's tumors) and by changes in the relative position of certain vertebrae, as in spondylolisthesis and allied conditions, is well known. In the pathologic conditions thus far mentioned, narrowing or deformation of the foramina is consequent upon some decrease in size, hardness or elasticity of those tissues which normally hold in place the bones encircling the foramen. A different mechanism of constriction occurs in primary arthritis of the apophyseal joints. The term arthritis is here used in its original signification, namely, to designate inflammation of a joint. As emphasized in a previous report,²⁴ only the apophyseal articulations are true joints, whereas the space between the bodies (centra) of adjacent vertebrae has nothing of the anatomic structure characteristic of an articular space. Considerable confusion has arisen from the fact that this intervertebral structure, which is essentially a synchondrosis, has often been called an intervertebral joint, and the pathologic conditions affecting it described as "arthritic." The term arthritis of the spine, or spondylarthritis, should apply only to diseases originating in the articulations (namely, the joints formed by the articular processes), whereas calcifications, exostoses and deformities involving the intervertebral spaces should be called hypertrophic spondylitis, or, according to Schmorl's fundamental work, deforming spondylosis, and not spondylarthritis. Roentgenologically, a distinction between "arthrosis," a degenerative lesion, and "arthritis," an inflammatory one, is not yet possible. In order to avoid adding to an already overloaded terminology, only the term spondylarthritis is here used. It is true that spondylarthritis is associated occasionally with deforming spondylosis; but, nevertheless, each of these diseases is a distinct and definitely characterized entity.

It is important to remember that spondylarthritis is primarily a disease (rheumatoid arthritis) of the synovial membranes of the apophyseal joints (E. Fraenkel,¹² recently confirmed by Guentz¹⁴ and others). In incipient stages, swelling of soft tissues may have already caused pressure upon nerve roots (Nathan²³). Roentgenologically, mottled demineralization of the articular processes is the first reliable sign. Haziness of the joint space may also be noticeable; roughening of the articular surfaces follows. Eventually, calcification of the capsule and ligaments, often associated with bony ankylosis of the facets, immobilizes the segment involved; hence the term "spondylar-

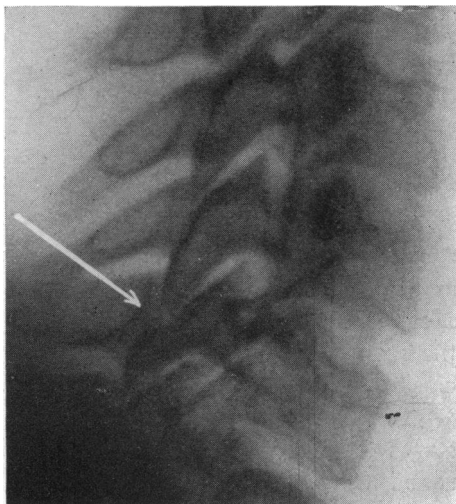


FIG. 6.—Rarefaction in the sixth cervical inferior articular process, with penetration of the superjacent process into it.

thrititis ankylopoietica" (Figs. 1C, 2C and 5). The process may then spread to the costotransversal joints and to the longitudinal ligaments which connect the vertebral bodies, whereby, in case of calcification of the latter, ossified fusion occurs of the whole spine or of parts of it (Bechterew type). The disease, which may become arrested at any stage, may affect the whole spine or one segment only; it may even be limited to part of a joint, such as the ligamentum flavum (Bakke⁵). Arthritis of the shoulders or the hips is sometimes superadded (Pierre-Marie-Struempell type). According to the literature on the subject, arthritis of the ileosacral joints, followed by ankylosis, is very commonly the first manifestation of "ankylopoietic spondylarthritis." In our own observations, however, arthritis and bony ankylosis of the lower dorsal apophyseal and costotransversal joints precede, often for several years, the involvement of the ileosacral region. This difference of opinion represents merely a difference in conception of the term "ankylopoietic." In the past, the diagnosis has mainly been based upon bony fusion of the vertebral bodies ("bamboo-spine"), which is characteristic of advanced stages commonly associated with ankylosis of other, *e.g.*, the ileosacral, joints. In our method, earlier changes, such as ankylosis of only a few facets, are made visible long before the ossifications leading to "bamboo-spine" occur. According to the results obtained by this method, we may state that, in the majority of cases, ankylosing arthritis involves the apophyseal joints first, and that only on rare occasions does ileosacral arthritis precede these changes. Hence, in radiculitis suggestive of a spinal lesion, it is imperative to examine the apophyseal articulations even in the absence of ileosacral changes—a conclusion of obvious practical importance.

The intervertebral disks are never primarily involved; only in advanced stages do they appear compressed, as it were, by the calcifications that surround them. Even in terminal stages, the roentgenologic aspect of an ankylosed spondylarthritic column ("bamboo-spine") is distinctly different from the appearance produced by exostotic fusions resulting from deforming spondylosis as first shown by Assmann.² Compression of nerve roots may occur at any stage of the disease, either by inflammatory swelling or by secondary calcifications, *e. g.*, those arthritic deformities of the facets and calcifications which concentrically involve the posterior margin formed by the longitudinal ligaments. In other cases, only parts of the circumference appear deformed by ossifications. As a rule, the narrowing of the foramen produced by this process is less marked and more irregular than the narrowing found in discogenetic disease. The roentgenologic diagnosis of spondylarthritic constriction, unless proved by extensive calcifications of the longitudinal ligaments, must be based upon ankylosis of the facets and ossification of periarticular tissues combined with absence of any subluxation of the facets and of a reduced intervertebral space—in other words, in the absence of signs suggestive of lesions of the disk. Except in a few border-line cases, these criteria will suffice to differentiate between primary spondylarthritic and so called arthritic changes consequent upon discogenetic diseases.

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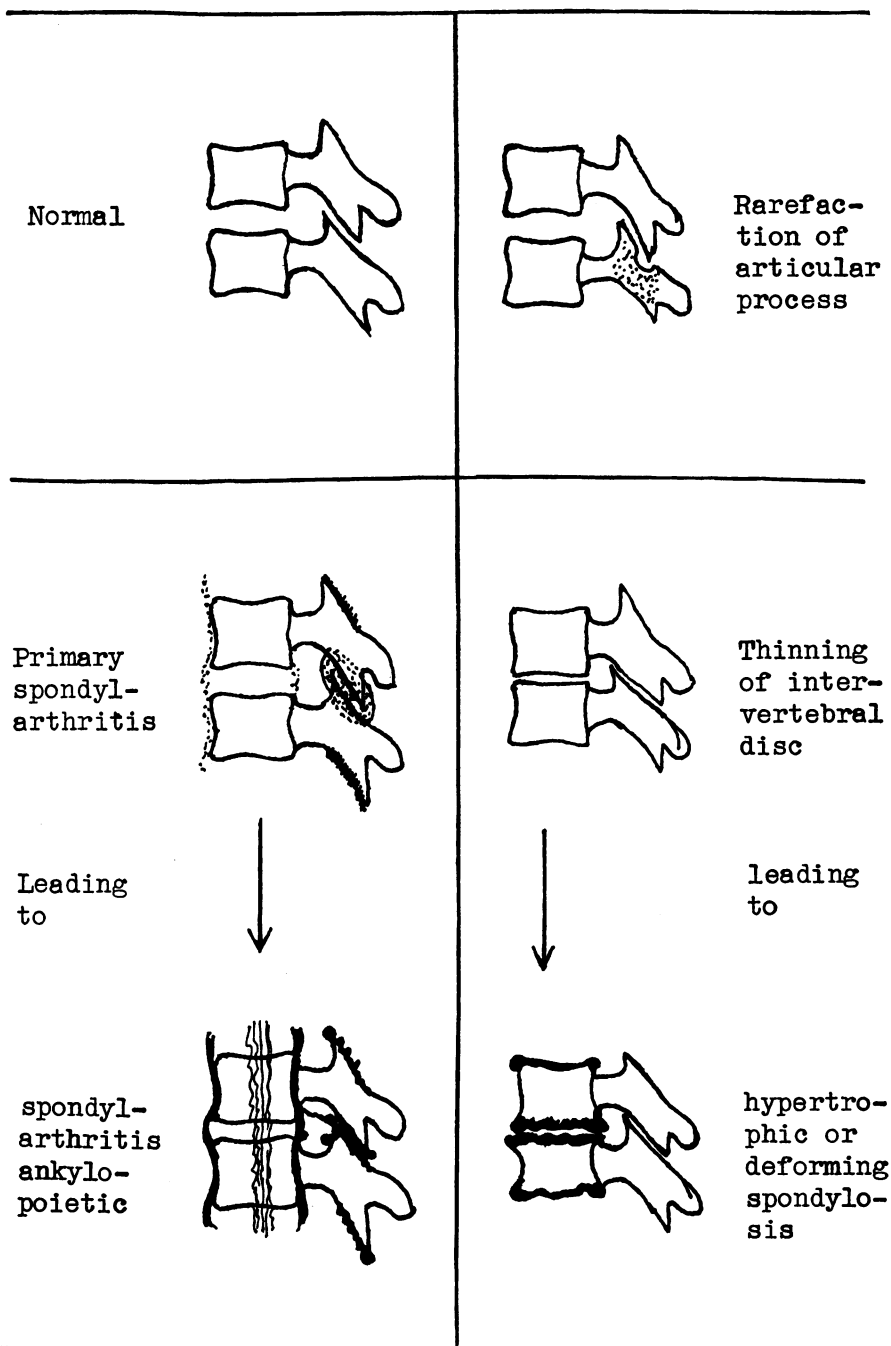


FIG. 7.—Mechanisms of narrowing.

Clinical Findings.—Regardless of the underlying pathologic process, narrowing of intervertebral foramina, as soon as it attains a sufficient degree, will produce pressure upon nerve roots. This syndrome has been called neurodociitis by Putti,²⁷ in 1927; the term is derived from neurodokon, *i.e.*, the bony channel through which nerves pass. While the roentgenologic signs in the great majority of cases are quite evident, the clinical symptoms and signs are exceedingly variable and very often not suggestive of a nerve lesion. Recurrent lumbago, vague pains in the chest, "rheumatism" of the shoulder are the first symptoms, often too slight and indefinite to make the patient seek medical advice. Because of the complete absence of signs typical of a neurogenous lesion, these complaints are usually attributed to myalgia or incipient arthritis. Gradually, in the course of many years, the symptoms become more persistent, until at last either paresthesia or atrophy of a group of muscles proves the involvement of nerves. In those moderately advanced cases that are seen by the physician, persistent sciatic pain, or low backache, is probably the commonest symptom. In the upper extremities, increasing interference with certain movements indicates the progress of the disease: a woman complains of discomfort felt in combing her hair, fastening her dress at the back, or lifting a pan; a man feels pain when putting on his coat, or carving meat, or raising his hat. Occasionally one finds a syndrome, first observed by Nachlass,²² of pseudo-angina pectoris produced by constriction of lower cervical foramina. In pains in the precordium associated with discomfort in the left shoulder in a person above 50 years of age, it is rather difficult to convince the patient and the attending physician of the spinal origin of the symptoms.²⁹

Although the diagnosis depends eventually upon the roentgenologic appearances, a number of clinical symptoms and signs have been found helpful for the differentiation of the underlying processes. The data analyzed in Table I are based upon 270 observations made during the last two years; they are, of course, no more than average figures subject to all the limitations inherent in clinical statistics.

Summing up the results of these clinical observations, we may state that the symptoms in discogenetic disease begin at the periphery, while pain and stiffness in the spine itself are the first symptoms noticed in spondylarthritis, and usually precede definitely the pains felt in the course of the nerves. This difference is probably due to the fact that diseases of the disk itself are not felt unless they lead to secondary compression, as the disk and its envelopes are devoid of nerves (Jung and Brunschwig¹⁸); whereas in spondylarthritis the inflammatory swelling itself obviously produces pain before the nerve roots undergo compression. The recumbent position and rest in bed conduce definitely to relief in spondylarthritis; but in discogenetic compression, patients commonly complain that their discomfort is elicited by rest and recumbency, and emphasize the fact that the pain prevents them from sleeping comfortably. Furthermore, whereas almost any motion, active or passive, causes pain in spondylarthritis, it is especially the movement involved in

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TABLE I
SYNOPTIC DATA OF CLINICAL SYMPTOMS AND SIGNS

Nature of the Data Recorded	Segmental Neuritis in Discogenetic Disease	Segmental Neuritis in Spondylarthritis	Segmental Neuritis in Atrophy of One Articular Process
Number of observations:	Cervical I-III*... 2 Cervical IV-VII... 56 Dorsal I-X..... 0 Dorsolumbar..... 31 Lumbar II-IV... 32 Lumbosacral.... 122 Systemic..... 0 Total..... 243	Cervical I-III.... 4 Cervical IV-VII... 4 Dorsal I-X..... 6 Dorsolumbar..... 5 Lumbar II-IV... 1 Lumbosacral.... 2 Systemic..... 4 Total..... 26	Cervical I-III.... 0 Cervical IV-VII... 4 Dorsal I-X..... 0 Dorsolumbar..... 0 Lumbar II-IV... 0 Lumbosacral.... 0 Systemic..... 0 Total..... 4
Age at which first symptoms occur:	30 to 40 years.	Any age including adolescence	Unknown
Age at which definite neuritis becomes evident:	Around 50 years	Variable	Unknown
Number of foramina involved:	1 to 3 per segment	Any number	One
Spontaneous pain in the spine itself:	Common in the lumbar, very rare in other segments	Common	Common
Tenderness on pressure upon the spinal segment involved:	Common	Variable; positive in early, often negative in advanced stages	Variable
Time of appearance of the pain:	Invariably the first symptom noticed	A late symptom	Early?
Restriction of mobility in the spine:	Common in the lumbar, rare in the cervical spine	Constant and pathognomonic	Absent
Sensation of stiffness in the spine:	Variable	Constant	Variable
Pains aggravated by:	Backward extension, dorsal recumbency (rest at night), walking, moving	Bending forward, rotation, erect position, backward stretching	Not examined
Pains relieved or diminished by:	Bending forward	Recumbent position (rest at night)	Not examined
Etiology:	Traumatic, degenerative or senile	Inflammatory, bacterial	Tuberculosis? A typical rheumatoid spondyl arthritis?

* The Roman numerals refer to the foramina involved: *e.g.*, Cervical VII means the foramen between the seventh cervical and the first dorsal vertebrae.

drawing the spine backward, as in lifting an object from the floor, which aggravates the discomfort in discogenetic disease. On the other hand, as a general rule, bending forward relieves the pain, owing to the fact that the lordotic position narrows the foramina, while the kyphotic position widens them (Brown⁶). In spondylarthritic ankylosis of the articular processes, the width of the foramen is not affected by any motion; hence, no movement of any kind affords relief. Before bony ankylosis takes place, bending forward may decrease the pressure upon the affected nerve and thus give some relief in either disease.

As mentioned above, the constriction of the foramina is in general less pronounced in spondylarthritis than in discogenetic disease; hence, segmental neuritis is more common in the latter. Moreover, spondylarthritis is a rare

lesion, while discogenetic disease is common. As for the few observations recorded concerning the peculiar condition associated with atrophy of a cervical articular process, the data are not numerous enough to allow of classification.

Therapy.—Long continued compression leads eventually to irreparable degeneration of parts of the nerve; accordingly, the treatment of the diseases under discussion is based primarily upon early recognition of the neurogenous origin of many "rheumatic" or "arthritic" symptoms. Relief from compression by operative grafting is well known to produce most satisfactory results in discogenetic disease of the lumbosacral junction. In cervical segmental neuritis, head traction has been advocated by Nachlass²² and by Hanflig;¹⁶ Turner and Oppenheimer²⁹ have also observed definite improvement after manual or mechanical traction in discogenetic disease of the cervical spine.

In spondylarthritic compression, traction has not given satisfactory results; in some instances, even aggravation of the symptoms has been observed by the present writer. Among the patients suffering from spondylarthrititis referred to in Table I, only five have undergone treatment in our hospital services; all of them acknowledge definite improvement following upon a series of six to 12 ultrashort-wave treatments.

In three patients, focal infection was assumed to be the cause of spondylarthrititis. The first, a male student, age 24, had been suffering from severe left sciatica for 11 months before he was referred to us. There was marked atrophy of the muscles and diminution of the reflexes of the left leg; the pains subsided only when the patient was at rest in bed; they had not responded to any of the modes of treatment employed, including vaccination, shock-therapy, all sorts of analgesics, salicylates, and roentgen irradiation. Even morphine gave only slight relief. Definite roughening of the articular surfaces of the left fourth and fifth lumbar apophyseal facets was found roentgenologically (11 months after beginning of the symptoms); the intervertebral spaces were perfectly normal. A focus of infection was therefore sought for; the tonsils, although not enlarged, emitted a few drops of greenish pus on pressure. Three days after tonsillectomy, the symptoms subsided entirely, and the patient is now cured. The second patient, a physician, age 37, was relieved after extraction of an infected tooth, of all the symptoms resulting from a similar condition of the upper dorsal segments. The third, an engineer, age 29, had been suffering for five months from severe precordial pain which occurred almost daily during his work. Physical, roentgenologic, and all kinds of laboratory examinations did not reveal any lesion of heart and aorta. There was a moderate tenderness of the lower cervical spine, but the patient had never felt spontaneous pain or any discomfort in the neck. Percussion of the spinous process of the seventh cervical vertebra elicited a severe attack of precordial pain similar to those stated in the history. On roentgenologic examination, very marked demineralization of the sixth and seventh cervical articular processes was then found. After treatment of an alveolar pyorrhea and of two infected molar roots, the patient was cured.

These observations correspond to the results of investigations showing the rôle of focal infection in the production of rheumatoid arthritis. They seem to us to add some clinical evidence to the histologic and roentgenologic findings already mentioned, which demonstrate that spondylarthritis is an inflammatory disease, probably of bacterial origin.

In a few cases of discogenetic disease, severe symptoms of recurrent radiculitis, lasting for ten years and more, subsided gradually in the course of a year without any therapy. In these patients, extensive exostoses are found, connecting the anterior and lateral borders of the vertebral bodies involved, and thus immobilizing the diseased area. It is possible that this bony fusion prevents the additional compression caused by certain physiologic movements. The mobility of the spine as a whole is not diminished, as sufficient mobility remains in adjacent segments.

SUMMARY

(1) In a large number of patients suffering from pain and discomfort suggestive of rheumatism or arthritis, segmental neuritis, resulting from compression of nerve roots, has been shown to be the cause of the symptoms.

(2) This compression is due chiefly to narrowing of intervertebral foramina caused by:

(a) Discogenetic disease, marked by collapse of foramina and subluxation of articular processes consequent upon thinning of intervertebral disks. Roentgenologic signs are: Subluxation of the said processes, narrowing of intervertebral spaces. Main clinical symptoms are: Discomfort, slight in the spine, severe in the periphery, aggravated at night.

(b) Inflammatory swelling, followed by ankylosis of the apophyseal joints in the course of primary spondylarthritis. Roentgenologic signs are: Ankylosis and deformities of the articular processes in the presence of normal intervertebral spaces. Clinical signs are: Symptoms beginning in the spine itself; stiffness of the spine; relief at night.

(c) Penetration of an articular process into a diseased subjacent process in the presence of normal disks and normal apophyseal joint spaces.

(3) The treatment varies with the mechanism of constriction: Mechanical widening of the foramina is indicated in discogenetic disease, and anti-inflammatory therapy in spondylarthritis.

(4) Observations concerning the bacterial origin of spondylarthritis and the rôle of focal infection are reported.

(5) The fundamental difference between deforming spondylosis and primary spondylarthritis makes it desirable to confine the term "spondylarthritis" to those diseases that involve the articular processes.

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